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PTO/SB/50 (08-00)

Approved for use through 12/30/2000. OMB 0651-0033

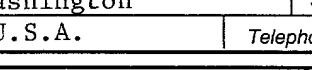
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09/22/00

**REISSUEPATENTAPPLICATIONTRANSMITTAL**

|  |   |   |  |          |
|--|---|---|--|----------|
| Address to:  |   | AttorneyDocketNo.                                     | 47382.000060                           |          |
| Assistant Commissioner for Patents   |   | FirstNameInventor                                     | Johnson, et al.                        |          |
| Box Reissue  |   | OriginalPatentNumber                                  | 5,812,249                              |          |
| Washington, DC 20231   |   | OriginalPatentIssueDate<br>(Month/Day/Year)           | 09/22/98                               |          |
|  |   | ExpressMailLabelNo.                                   |  |          |
| APPLICATION FOR REISSUE OF:<br>(Check applicable box)  |   | <input checked="" type="checkbox"/> Utility Patent    | <input type="checkbox"/> Design Patent |          |
|  |   |   | <input type="checkbox"/> Plant Patent  |          |
| APPLICATION ELEMENTS (37 CFR 1.173)  |   |   |  |          |
| <p>1. <input checked="" type="checkbox"/> Fee Transmittal Form (PTO/SB/56)<br/>(Submit an original, and a duplicate for fee processing)</p> <p>2. <input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.</p> <p>3. <input checked="" type="checkbox"/> Specification and Claims in double column copy of patent format (amended, if appropriate)</p> <p>4. <input checked="" type="checkbox"/> Drawing(s) (proposed amendments, if appropriate)</p> <p>5. <input type="checkbox"/> Reissue Oath/Declaration (original or copy)<br/>(37 C.F.R. § 1.175)(PTO/SB/51 or 52)</p> <p>6. Original U.S. Patent currently assigned?</p> <p><input checked="" type="checkbox"/> Yes <input type="checkbox"/> No<br/>(If Yes, check applicable box(es))</p> <p><input checked="" type="checkbox"/> Written Consent of all Assignees (PTO/SB/53)</p> <p><input checked="" type="checkbox"/> 37 C.F.R. § 3.73(b) Statement (PTO/SB/96) <input checked="" type="checkbox"/> Power of Attorney</p> |   |   |  |          |
| <p>ACCOMPANYING APPLICATION PARTS</p> <p>7. <input type="checkbox"/> Statement of status/support for all changes to the claims. See 37 CFR 1.173(c).</p> <p>8. <input type="checkbox"/> Original U.S. Patent for surrender</p> <p><input type="checkbox"/> Ribbed Original Patent Grant</p> <p><input type="checkbox"/> Statement of Loss (PTO/SB/55)</p> <p>9. <input type="checkbox"/> Foreign Priority Claim (35 U.S.C. 119) (if applicable)</p> <p>10. <input type="checkbox"/> Information Disclosure Statement (IDS)/PTO-1449 <input type="checkbox"/> Copies of IDS Citations</p> <p>11. <input type="checkbox"/> English Translation of Reissue Oath/Declaration (if applicable)</p> <p>12. <input checked="" type="checkbox"/> Preliminary Amendment</p> <p>13. <input checked="" type="checkbox"/> Return Receipt Postcard (MPEP 503) (Should be specifically itemized)</p> <p>14. Other: <u>...Unsigned Re-Issue Declaration.....</u></p>   |   |   |  |          |
| 15. CORRESPONDENCE ADDRESS   |   |   |  |          |
| <input type="checkbox"/> Customer Number or Barcode Label<br><small>(Insert Customer No. or Attach barcode label here)</small>   |   | <input type="checkbox"/> Correspondence address below |  |          |
| Name   | James G. Gatto  |   |  |          |
| Address  | Hunton & Williams<br>1900 K Street, N.W.  |   |  |          |
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| NAME (Print/Type)  | Devin S. Morgan   |   | Registration No. (Attorney/Agent)      | 45,562   |
| Signature  |  |   | Date                                   | 09/22/00 |

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| REISSUE APPLICATION FEE TRANSMITTAL FORM   |                                      |   |  | Docket Number (Optional)<br>47382.000060 |              |                           |                           |     |
|--|--------------------------------------|---|--|--|--------------|---------------------------|---------------------------|-----|
| Claims as Filed - Part 1   |                                      |   |  |  |              |                           |                           |     |
| Claims in Patent   |                                      | Number Filed in Reissue Application   | (3) Number Extra                       | Small Entity                             |              | Other than a Small Entity |                           |     |
|  |                                      |   |  | Rate                                     | Fee          | Rate                      | Fee                       |     |
| (A) 9  | Total Claims (37 CFR 1.16(j))        | (B) 9   | **** =                                 | x \$ ____ =                              |              | x \$ 18 =                 | 0                         |     |
| (C) 3  | Independent Claims (37 CFR 1.16(i))  | (D) 3   | * =                                    | x \$ ____ =                              |              | x \$ 78 =                 | 0                         |     |
|  |                                      |   |  | Basic Fee (37 CFR 1.16(h)) \$ _____      |              |                           |                           |     |
|  |                                      |   |  | Total Filing Fee \$ _____                |              | OR \$ 690.00              |                           |     |
| Claims as Amended - Part 2   |                                      |   |  |  |              |                           |                           |     |
|  | (1) Claims Remaining After Amendment |   | (2) Highest Number Previously Paid For | (3) Extra Claims Present                 | Small Entity |                           | Other than a Small Entity |     |
|  |                                      |   |  |  | Rate         | Fee                       | Rate                      | Fee |
| Total Claims (37 CFR 1.16(j))  | *** 20                               | MINUS   | ** 20                                  | * = 0                                    | x \$ ____ =  | x \$ 18 =                 | 0                         |     |
| Independent Claims (37 CFR 1.16(i))  | *** 5                                | MINUS   | **** 3                                 | = 2                                      | x \$ ____ =  | x \$ 78 =                 | 156.00                    |     |
|  |                                      |   |  | Total Additional Fee \$ _____            |              | OR \$ 156.00              |                           |     |
| <p>* If the entry in (D) is less than the entry in (C), write "0" in column 3.</p> <p>** If the "Highest Number of Total Claims Previously Paid For" is less than 20, write "20" in this space.</p> <p>*** After any cancellation of claims.</p> <p>**** If "A" is greater than 20, use (B-A); if "A" is 20 or less, use (B-20).</p> <p>***** "Highest Number of Independent Claims Previously Paid For" or Number of Independent Claims in Patent (C).</p>  |                                      |   |  |  |              |                           |                           |     |
| <p><input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.</p> <p><input type="checkbox"/> Please charge Deposit Account No. _____ in the amount of _____.</p> <p><input type="checkbox"/> Aduplicate copy of this sheet is enclosed.</p> <p><input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees under 37 CFR 1.16 or 1.17 which may be required, or credit any overpayment to Deposit Account No. 50-0206.</p> <p><input type="checkbox"/> Aduplicate copy of this sheet is enclosed.</p> <p><input checked="" type="checkbox"/> A check in the amount of \$ 846.00 to cover the filing/additional fee is enclosed.</p> <p><input type="checkbox"/> Payment by credit card Form PTO-2038 is attached.</p> |                                      |   |  |  |              |                           |                           |     |
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| 09/22/00   |                                      |  |  |  |              |                           |                           |     |
| Date   |                                      | Signature of Applicant, Attorney or Agent of Record                                 |  |  |              |                           |                           |     |
|  |                                      | Devin S. Morgan<br>Typed or printed name  |  |  |              |                           |                           |     |

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PATENT  
Attorney Docket No. 47382.000060

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Inventors:            Johnson et al.            )  
    )  
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Patent No.:            5,812,249            )  
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    )  
Issue Date:            September 22, 1998    )  
    )  
    )  
Application No.:       08/717,226            )  
    )  
    )  
Filing Date:            September 26, 1996    )

**PRELIMINARY AMENDMENT AND  
REQUEST FOR TRANSFER OF ORIGINAL DRAWINGS**

Assistant Commissioner of Patents  
Washington, D.C. 20231

Sir:

**PRELIMINARY AMENDMENT**

Please amend the enclosed reissue application as follows.

*In the claims:*

Amend claim 1 as follows:

1. (Amended) Apparatus for determining speed and acceleration of a motor vehicle traveling on a roadway comprising:

a first radiation source producing a [visible entrance laser] first beam and arranged at one side of the roadway;

a first detector arranged at an opposite side of the roadway to receive said [visible entrance laser] first beam from said first radiation source for producing an output signal indicating a presence or

absence of said [visible entrance laser] first beam;

a second radiation source producing a [visible exit laser] second beam and arranged at said one side of the roadway and being spaced apart by a predetermined distance from said first radiation source;

a second detector arranged at said opposite side of the roadway to receive said [visible exit laser] second beam from said second radiation source for producing an output signal indicating the presence or absence of said [visible exit laser] second beam;

wherein front and rear wheels of the motor vehicle each interrupt said [visible entrance laser] first beam and said [visible exit laser] second beam and the interruptions are detected by said first and second detectors; and

analyzing means receiving said output signals from said first and second detectors for calculating the speed and acceleration of the motor vehicle.

Amend claim 2 as follows:

2. (Amended) The apparatus according to claim 1 wherein the analyzing means further comprises:

timing means for measuring time;

determining means for producing a pulse when said front wheel and rear wheel passes into and departs from said first beam and said second beam, respectively;

memory means for storing each measured time when said determining means produces said pulse indicating that said front and rear wheels passed into and out of said [visible entrance laser] first beam and said [visible exit laser] second beam, respectively; and

calculating means for calculating said speed and acceleration using said predetermined distance and each of said measured times recorded by said recording means.

Amend claim 5 as follows:

5. (Amended) The apparatus according to claim 2 wherein said [visible entrance laser] first beam and said [visible exit laser] second beam are unmodulated.

Amend claim 7 as follows:

7. (Amended) A method for determining speed and acceleration of a motor vehicle traveling on a roadway comprising the steps of:

producing a plurality of [visible laser] beams spaced apart by a predetermined distance and

directed across the roadway;

arranging the plurality of [visible laser] beams at a height to be interrupted by front and rear wheels of the motor vehicle;

determining when the front and rear wheels pass into and out of each of said plurality of [visible laser] beams;

producing a time measurement at each determined occurrence;

recording each of said time measurements when the front and rear wheels pass into and out of each of said plurality of [visible laser] beams, respectively; and

calculating a speed value and an acceleration value from said fixed distance and each of the time measurements recorded in said step of recording.

Amend claim 9 as follows:

9. (Amended) Apparatus for detecting acceleration of a motor vehicle passing along a roadway comprising:

means for producing first and second [visible laser] beams spaced apart by a predetermined

distance on one side of the roadway and arranged at a height above the roadway so as each to be interrupted by a front wheel and a rear wheel of the motor vehicle;

detector means arranged at a side of the roadway opposite said one side for receiving said first and second [visible laser] beams and producing respective output signals indicating interruptions of said first and second [visible laser] beams by the front and rear wheels of the motor vehicle;

measuring means for receiving said output signals from said detector means for producing time measurements at each occurrence of said interruptions of said first and second [visible laser] beams and for producing time measurements at each resumption of each interrupted first and second [visible laser] beams; and

calculating means receiving said time measurements from said measuring means for calculating an acceleration of the motor vehicle based on said predetermined distance.

Please add the following new claims:

10. (New) Apparatus for determining speed and/or acceleration of a vehicle comprising:

at least one radiation source projecting radiation across the vehicle's path;

at least one detector receiving at least a portion of the projected radiation; and

an analyzer for receiving a plurality of signals from said at least one detector, said analyzer calculating a speed and/or acceleration of the vehicle based upon at least two points of intersection between the radiation and the vehicle's path that are separated by a predetermined distance.

11. (New) The apparatus of claim 10, wherein the analyzer includes a timer, a memory, and a calculating circuit.

12. (New) The apparatus of claim 10, further comprising a vehicle emission testing system for receiving the calculated speed and/or acceleration of the vehicle.

13. (New) The apparatus of claim 10, wherein the radiation includes radiation in the visible light spectrum.

14. (New) The apparatus of claim 10, wherein the radiation is unmodulated.

15. (New) The apparatus of claim 10, wherein the radiation includes a plurality of laser beams.

16. (New) The apparatus of claim 10, wherein the radiation includes an entrance beam and an exit beam.

17. (New) The apparatus of claim 10, wherein said at least one radiation source is arranged on one side of the vehicle's path and said at least one detector is arranged on an opposite side of the vehicle's path.

18. (New) A method for determining speed and/or acceleration of a vehicle comprising the steps of:

projecting radiation across the vehicle's path;

identifying a first time when a first portion of the vehicle breaks the projected radiation at a first location;

identifying a second time when the first portion of the vehicle breaks the projected radiation at a second location; and

calculating the vehicle's speed using the first and second times and a predetermined distance between the first location and the second location.

19. (New) The method of claim 18, further comprising the steps of:

identifying a third time when a second portion of the vehicle breaks the projected radiation at the first location;

identifying a fourth time when the second portion of the vehicle breaks the projected radiation at the second location; and

calculating the vehicle's speed and/or acceleration using the first, second, third, and fourth times and the predetermined distance between the first location and the second location.

20. (New) The method of claim 18 further comprising the steps of:

identifying a fifth time when the first portion of the vehicle leaves the projected radiation at the first location;

identifying a sixth time when the first portion of the vehicle leaves the projected radiation at the second location;

identifying a seventh time when the second portion of the vehicle leaves the projected radiation at the first location;

PATENT  
Attorney Docket No. 47382.000060

identifying an eighth time when the second portion of the vehicle leaves the projected radiation at the second location; and

calculating the vehicle's speed and/or acceleration using the first, second, third, fourth, fifth, sixth, seventh, and eighth times and the predetermined distance between the first location and the second location.

REQUEST FOR TRANSFER OF ORIGINAL DRAWINGS

Please transfer the drawings from the original patent file of the above referenced patent to the reissue application file. Copies of the original drawings, as they appear in the issued patent, have been enclosed.

REMARKS

Applicants believe that the original patent, U.S. Patent No. 5,812,249, granted September 22, 1998, is wholly or partly inoperative or invalid by reason of the patentees claiming more or less than they had the right to claim in the patent. At least one error upon which this reissue application is based is the unnecessary limitation of "visible" which was included in claims 1, 2, 5, 7 and 9. Other errors exist and are corrected by this amendment. Every error corrected in this reissue application, including all errors corrected in this amendment, arose without any deceptive intention on the part of the applicants.

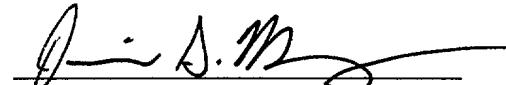
PATENT  
Attorney Docket No. 47382.000060

CONCLUSION

Prompt examination and favorable action are hereby respectfully requested. Should the examiner believe that an interview, either personal or by telephone, would expedite prosecution of this reissue application, the undersigned would welcome such an opportunity.

Respectfully submitted,

HUNTON & WILLIAMS



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Registration No. 45,562  
1900 K Street NW  
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Dated: September 22, 2000

**SPEED AND ACCELERATION MONITORING  
DEVICE USING VISIBLE LASER BEAMS**

**BACKGROUND OF THE INVENTION**

Motor vehicles are one of the major contributors to air pollution both in the United States and abroad. Thus, it is desirable to measure exhaust emissions from automobiles under actual operating conditions in order to identify excessively polluting vehicles and either have them repaired or have them removed from the road. Apparatus for detecting and measuring relative concentrations of pollutants such as HC, CO, and CO<sub>2</sub> in the exhaust emissions from automobiles under operating conditions have been developed. Examples of such apparatus are shown in U.S. Pat. Nos. 5,343,043 (Johnson) and 5,210,702 (Bishop, et al.), which are incorporated by reference herein.

In order to properly analyze the exhaust emissions data obtained, the speed and/or acceleration of the vehicle at the time the exhaust emissions information was obtained is very useful. More specifically, the emissions test results can be influenced by the specific mode of operation, for example, acceleration or deceleration, of the vehicle under the test. Determining the mode of operation must be performed in a very short distance of travel, so as to capture instantaneously the specific accelerator position. This in turn supplies information about fuel enrichment and fuel deprivation of the engine at the specific time of the emissions test.

Devices have been developed in the past to determine the speed of vehicles. One such device is the radar detector used by law enforcement agencies. Although such radar devices are quite useful, radar waves can reflect off several points of the same vehicle, resulting in obtaining different speeds for the same vehicle traveling at a constant velocity. Another device for determining the speed of motor vehicles is the mechanical switch. Mechanical switches, however, have a great variance in response time. Also, cumbersome methods are needed, such as taping the sensors down to the highway, to keep the switches at a fixed length apart. Still another device is the use of modulated infrared laser beams. The modulated infrared laser beam has a set time for the beam to be on and off. This time translates into time steps that can cause error in the detection of the laser beam and, thus, accurate and reliable results may not be obtained.

**BRIEF SUMMARY OF THE INVENTION**

In view of the foregoing, it is one object of the present invention to provide an improved apparatus and method for monitoring the speed and acceleration of a motor vehicle, especially over a short distance.

It is another object of the present invention to provide an apparatus and method for accurately and reliably obtaining the speed and acceleration of a motor vehicle using visible laser beams positioned low to the ground.

Another object of the present invention is to detect at least the front wheel and the rear wheel of a motor vehicle using visible, non-modulated laser beams to obtain the speed and acceleration of the motor vehicle.

It is yet another object of the present invention to use the speed and acceleration data in combination with data on pollutants obtained from motor vehicles in-use to analyze exhaust emissions data.

The invention consists of certain novel features and a combination of parts hereinafter fully described, illustrated in the accompanying drawings, and particularly pointed out in the appended claims, it being understood that various

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changes in the details may be made without departing from the spirit, or sacrificing any of the advantages, of the present invention.

#### BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

For the purpose of facilitating an understanding of the invention there is illustrated in the accompanying drawings a preferred embodiment thereof, from an inspection of which, when considered in connection with the following description, the invention, its construction and operation, and many of its advantages should be readily understood and appreciated.

FIG. 1 is a schematic diagram of an embodiment of the present invention shown in use across a roadway;

FIG. 2 is a block diagram of an embodiment of the present invention;

FIG. 3 is an pictorial view of a portion of the present invention;

FIG. 4 is a block diagram showing the calculator unit of FIG. 2 in more detail; and

FIG. 5 is a vehicle emission testing unit known in the prior art and useful with the embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 illustrates one embodiment of the present invention in use along a roadway 10. A motor vehicle 11 having at least a front wheel 12 and a rear wheel 13 is traveling along a roadway 10. The present invention includes a first radiation source 14, a second radiation source 15, a first detector 16 and a second detector 17. A visible entrance laser beam 18 is emitted from the first radiation source 14 and received by the first detector 16. An visible exit laser beam 19 is emitted from the second radiation source 15 and received by the second detector 17. The entrance laser beam 18 and the exit laser beam 19 are separated by a known fixed distance, d. Although the distance, d, can be any length, in a preferred embodiment, the distance, d, is small, preferably 70 inches.

In a preferred embodiment, the entrance laser beam 18 and the exit laser beam 19 are visible, that is, the laser beams are in the visible light spectrum. Visible laser beams 18, 19, allow the radiation sources 14, 15, to be accurately and precisely aligned with the respective detectors 16, 17, without requiring additional alignment beams, and to be positioned accurately close to the ground to allow only the wheels 12, 13, to be detected. The use of visible laser beams 18, 19, allow the fixed distance, d, between the entrance laser beam 18 and exit laser beam 19 to be precisely set without requiring additional alignment equipment.

The visible laser beams 18, 19, are not modulated and are at a low power level. The use of unmodulated visible laser beams 18, 19, is radically different from the normal infrared lasers or other modulated light sources which spread out over a wide area with low specific area radiation intensity. With the sensors presently known for use, the modulation and beam width can cause inaccuracies that are not tolerable, especially for obtaining the speed, S, and acceleration, A, of a motor vehicle 11 over a short distance, such as 70 inches in the described embodiment.

The detectors 16, 17, can be photo transistors with a 1.5" lens, not shown, and with a bandpass filter of the proper wavelength. The lens allows for some amount of mechanical movement of the detectors 16, 17, without resulting in a

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false detection of signals. In addition, the detectors 16, 17, may be operated in a saturated mode, which allow them to reject mechanical and electrical noise.

In one embodiment, in order to measure the speed, S, at which a vehicle such as the motor vehicle 11 is traveling, the time period for the motor vehicle 11 to break the entrance laser beam 18 and then break the exit laser beam 19 over a fixed distance, d, is measured in an analyzer 20 based on the known distance d and the outputs of the detectors 16, 17. In the following description, the time when the motor vehicle 11 enters the path of any of the laser beams 18, 19, will be referred to as a "break", and the time when the motor vehicle 11 leaves the path of any of the respective laser beams 18, 19, and the laser beam is re-established, it will be called a "make." The acceleration of the motor vehicle 11 can be calculated in the analyzer 20 by using the rate of change of the speed detected using the front and rear wheels 12, 13, and the two detectors 16, 17.

As shown in the block diagram of FIG. 2, the analyzer 20 of the present invention includes a timer 30, such as a counter and a clock for measuring time. There are already known various kinds of timers 30 for measuring time, so that it need not be described in detail herein. The timer 30 starts timing the instant the front wheel of the motor vehicle 11 breaks the entrance laser beam 18. The analyzer 20 includes a determining circuit 40 for producing a pulse when the motor vehicle 11 breaks and makes each of the entrance laser beam 18 and the exit laser beam 19. For example, the determining circuit 40 may include a circuit, mechanism and/or algorithm for detecting the presence and absence of the visible laser beam using the respective outputs from the detectors 16, 17. The determining circuit 40 may comprise flip-flops or one-shots that are triggered by changes in the signal levels of the outputs from the respective detectors 16, 17 to indicate the respective break and make of the entrance laser beam 18 and the exit laser beam 19.

As shown in FIG. 2, the analyzer 20 also includes a storage circuit or memory 50 for recording the elapsed time each event occurs as timed by the timer 30 that is triggered by the output of the determining circuit 40. For example, the recorder 50 may store the times in the random access memory of a computer forming part of the analyzer 20. The times for the events that the recorder 50 records include the time when the front wheel 13 of the motor vehicle 11 breaks the entrance beam 18, the time when the entrance laser beam 18 is made or re-established, the time when the front wheel 12 of the motor vehicle 11 breaks the exit beam 19, the time when the exit beam 19 is re-established, the time when the rear wheel 13 of the motor vehicle 11 breaks the entrance laser beam 18, and the time when the entrance laser beam 18 is re-established, the time when the rear wheel 13 of the motor vehicle 11 breaks the exit laser beam 19, and the time when the exit laser beam 19 is re-established.

A calculating circuit 60, as illustrated in the block diagram of FIG. 2, is included in analyzer 20 of the present invention. The calculating circuit 60 calculates the speed and the rate of change of the speed using the fixed distance, d, and from each of the eight time values recorded by the recorder 50 for the various events. The calculating circuit 60 may include a computer, calculator, and/or any device, mechanism or algorithm for manipulating data and/or performing mathematical operations on the data, in order to calculate the speed, S, and acceleration, A, as will be described below. A suitable calculating circuit 60 is shown in FIG. 4. The values that the calculating circuit 60 calculates represents the speed, S, in miles per hour, or kilometers per hour, of the front and rear wheels and using the stored speed values, the calculating

circuit 60 calculates the acceleration, A, of the motor vehicle 11 in miles per hour per hour, feet per second per second, centimeters per second per second, or whatever units are best used in the vehicle emissions testing unit 70, such as the one described in the above-identified U.S. Pat. No. 5,343,043 and as shown in FIG. 5 herein.

As illustrated in FIG. 3, the motor vehicle 11 has at least a front wheel 12 and a rear wheel 13. In a preferred embodiment, the first radiation source 14, the second radiation source 15, the first detector 16 and the second detector 17 are arranged to allow the front wheel 12 and the rear wheel 13 of a motor vehicle 11 to break and make each of the entrance laser beam 18 and exit laser beam 19. The visible laser beams 18, 19 are spaced apart by a distance  $d$  that is less than the wheelbase of the vehicle. Thus, in order to measure speed,  $S$ , and acceleration,  $A$ , of the motor vehicle 11 using the front wheel 12 and rear wheel 13, the time of the following events, which are determined by the determining circuit 40 and the timer 30 are recorded by the recorder 50:

$t_{1a}$  is the time when the front wheel breaks the entrance laser beam;

$t_{1b}$  is the time when the front wheel leaves the entrance laser beam;

$t_{2a}$  is the time when the front wheel breaks the exit laser beam;

$t_{2b}$  is the time when the front wheel leaves the exit laser beam;

t<sub>3a</sub> is the time when the rear wheel breaks the entrance laser beam;

t3b is the time when the rear wheel leaves the entrance laser beam;

t4a is the time when the rear wheel breaks the exit laser beam; and

$t_{4b}$  is the time when the rear wheel leaves the exit laser beam.

As shown in the block diagram in FIG. 2, the preferred embodiment includes a timer 30 for measuring time. The timer 30 starts counting upon the front wheel 12 of the motor vehicle 11 breaking the entrance laser beam 18.

In the preferred embodiment, the calculating circuit 60, as illustrated generally in the block diagram of FIG. 2 and shown more specifically in FIG. 4, calculates speed,  $S$ , and acceleration,  $A$ , from the fixed distance,  $d$ , and from each time for the various events recorded by the recorder 50. In a preferred embodiment, the calculating circuit 60 calculates the speed,  $S$ , as  $S = (Speeda + Speedb)/2$  and the acceleration,  $A$ , as  $A = (Accela + Accelb)/2$ ; wherein:

$$\text{Speeda} = (S2a + S1a)/2;$$

$$Speed_b = (S2b + S1b)/2;$$

$$S1a-d/(2a-11a) = (3600/(5280-12));$$

$$S1b-d/(t2b-t1b) = (3600/(5280-12))$$

$$S2a = d / (t4a - t3a) = (3600 / (5280 - 12));$$

$$S2b-d/(t4b-t3b) = (3600/(5280-12))$$

### Accela-Delta Va/Delta Ta

Accelb=DeltaVb/DeltaTb;

Delta Va=S2a-S1a;

$$\Delta t_a = ((t_3 - t_1) + (t_4 - t_2)) / 2$$

Delta Vb=S2b-S1b;

$$\Delta Tb = ((13b - 11b) + (14b - 12b)) / 2;$$

The constant 3600/(5280\*12) converts units from inches per second to miles per hour.

In addition to reducing and/or eliminating the above-mentioned problems, the use of a radiation source and

detector arrangement, as shown in FIG. 3, to provide visible laser beams 18, 19, at a position, that is, height, above the roadway 10 so as to detect the wheels 12, 13, only, would also gather twice as much data as simply detecting the front portion of the motor vehicle, that could be used for verification against the first measurement of speed, S, and acceleration, A.

In operation, when a two axle motor vehicle 11 is driven along a roadway 10, the front wheel 12 breaks the visible entrance laser beam 18. The occurrence of this event as detected by detector 16 and indicated by a pulse from the determining circuit 40 starts the timer or counter 30. The recorder 50 records the time of this event as indicated by the timer 30. When the determining circuit 40 produces a pulse indicating that the entrance laser beam 18 is re-established, that is, make, the time of occurrence of this event as measured by the timer 30 is recorded by the recorder 50. When the determining circuit 40 indicates that the front wheel 12 breaks the exit laser beam 19, the time of this event as measured by the timer 30 is recorded by the recorder 50. When the determining circuit 40 indicates that the exit laser beam 19 is re-established, that is, make, the time of occurrence of this event as measured by the timer 30 is recorded by the recorder 50. When the determining circuit 40 indicates that the rear wheel 13 breaks the entrance laser beam 18 the recorder 30 records the time of occurrence of this event as measured by the timer 30. When the determining circuit 40 indicates that the entrance laser beam 18 is re-established, that is, make, the time of occurrence of this event as measured by the timer 30 is recorded by the recorder 50. When the determining circuit 40 indicates that the rear wheel 13 breaks the exit laser beam 19, the time of occurrence of this event as measured by the timer 30 is recorded by the recorder 50. When the determining circuit 40 indicates that the exit laser beam 19 is re-established, that is, make, the time of occurrence of this event as measured by the timer 30 is recorded by the recorder 50. Using these stored values and the fixed distance d the speed, S, and the acceleration, A, of the motor vehicle 11 is then calculated.

As shown in FIGS. 1 and 2, the present invention includes a vehicle emissions test unit 70 for obtaining exhaust emissions data such as the relative concentrations of HC, CO and CO<sub>2</sub> from motor vehicles 11. Conventional devices for obtaining exhaust emissions data are known in the art such as U.S. Pat. Nos. 5,343,043 (Johnson) and 5,210,702 (Bishop, et al.) and will not be described herein. The analyzer 20 may be a part of the vehicle emissions test unit 70 or can be a separate unit.

As shown in FIGS. 1 and 2, the present invention may include a read out device 80, such as a monitor or screen, a digital display or printer, to display information, such as speed and acceleration, of the motor vehicle 11.

The use of the present invention to obtain an accurate value for the speed, S, and acceleration, A, of a motor vehicle 11 which can be used in combination with vehicle emissions information obtained from the same motor vehicle 11, allows accurate and reliable information to be obtained regarding the motor vehicle 11 that is being driven along a roadway 10.

The events and data recorded in Table 1 below are indicative of a normal speed/acceleration test, and are only exemplary and should not be used to limit the scope of the invention as set forth herein.

TABLE 1

| Speed and Acceleration Monitor Formulas and Sample Data |  |  |
|---|--|--|
| Label   | Length (inches)                                  |  |
| d   | 70   |  |
| Label   | uSec   | Event                                  |
| T1 (t1a)  | 0.000000   | Front wheel breaks entrance laser beam |
| T2 (t1b)  | 0.070110   | Front wheel leaves entrance laser beam |
| T3 (t2a)  | 0.194128   | Front wheel breaks exit laser beam     |
| T4 (t2b)  | 0.262409   | Front wheel leaves exit laser beam     |
| T5 (t3a)  | 0.308330   | Rear wheel breaks entrance laser beam  |
| T6 (t3b)  | 0.378142   | Rear wheel leaves entrance laser beam  |
| T7 (t4a)  | 0.499250   | Rear wheel breaks exit laser beam      |
| T8 (t4b)  | 0.567508   | Rear wheel leaves exit laser beam      |
| <hr/>   |  |  |
| S1a   | $70/((t2a-t1a) * (3600/(5280 * 12))) = 20.43789$ |  |
| S1b   | $70/((t2b-t1b) * (3600/(5280 * 12))) = 20.68275$ |  |
| S2a   | $70/((t4a-t3a) * (3600/(5280 * 12))) = 20.88684$ |  |
| S2b   | $70/((t4b-t3b) * (3600/(5280 * 12))) = 21.00310$ |  |
| Delta Ta  | $((t2a-t1a) + (t4a-t3a))/2 = 0.30698$            |  |
| Delta Tb  | $((t2b-t1b) + (t4b-t3b))/2 = 0.30657$            |  |
| Delta Va  | $S2a - S1a = 0.39396$                            |  |
| Delta Vb  | $S2b - S1b = 0.32035$                            |  |
| Speeda  | $(S2a + S1a)/2 = 20.68737$                       |  |
| Speedb  | $(S2b + S1b)/2 = 20.84293$                       |  |
| S   | $(Speeda + Speedb)/2 = 20.76515$                 |  |
| Accela  | $Delta Va/Delta Ta = 1.299631$                   |  |
| Accelb  | $Delta Vb/Delta Tb = 1.04949$                    |  |
| A   | $(Accela + Accelb)/2 = 1.17229$                  |  |

Additionally, a system for detecting the speed of motor vehicles could also be used without emissions testing by law enforcement agencies. Such a system may be assembled at one location of the roadway and transmit information, such as the speed and a photograph of the motor vehicle, to a police officer waiting at another location along the roadway.

Thus, there has been described a method and apparatus for obtaining the speed and acceleration of a motor vehicle having many advantages. While the invention has been described in connection with preferred and illustrative embodiments, it should be understood that variations will occur to those skilled in the art, and the invention is to be limited only by the claims appended hereto and equivalents.

We claim:

1. Apparatus for determining speed and acceleration of a motor vehicle traveling on a roadway comprising:
  - a first radiation source producing a visible entrance laser beam and arranged at one side of the roadway;
  - a first detector arranged at an opposite side of the roadway to receive said visible entrance laser beam from said first radiation source for producing an output signal indicating a presence or absence of the visible entrance laser beam;
  - a second radiation source producing a visible exit laser beam and arranged at said one side of the roadway and being spaced apart by a predetermined distance from said first radiation source;
  - a second detector arranged at said opposite side of the roadway to receive said visible exit laser beam from said second radiation source for producing an output signal indicating the presence or absence of the visible exit laser beam;
 wherein front and rear wheels of the motor vehicle each interrupt said visible entrance laser beam and said visible exit laser beam and the interruptions are detected by said first and second detectors; and

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analyzing means receiving said output signals from said first and second detectors for calculating the speed and acceleration of the motor vehicle.

2. The apparatus according to claim 1 wherein the analyzing means further comprises:

Timing means for measuring time;

determining means for producing a pulse when said front wheel and rear wheel passes into and departs from said visible entrance laser beam and said visible exit laser beam, respectively;

memory means for storing each measured time when said determining means produces said pulse indicating that said front and rear wheels passed into and out of said visible entrance laser beam and said visible exit laser beam, respectively; and

calculating means for calculating said speed and acceleration using said predetermined distance and each of said measured times recorded by said recording means.

3. The apparatus according to claim 2 further comprising:  
vehicle emissions testing means receiving said calculated  
speed and acceleration from said analyzing means for  
obtaining exhaust emissions data from the motor  
vehicle; and

display means for displaying said speed and acceleration calculated by said analyzing means.

4. The apparatus according to claim 2 wherein said predetermined distance is substantially equal to 70 inches.

5. The apparatus according to claim 2 wherein said visible entrance laser beam and said visible exit laser beam are unmodulated.

6. The apparatus according to claim 2 wherein said first detector and said second detector include a photo transistor having a lens and a bandpass filter.

7. A method for determining speed and acceleration of a motor vehicle traveling on a roadway comprising the steps of:

producing a plurality of visible laser beams spaced apart by a predetermined distance and directed across the roadway;

arranging the plurality of visible laser beams at a height to be interrupted by front and rear wheels of the motor vehicle;

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determining when the front and rear wheels pass into and out of each of said plurality of visible laser beams; producing a time measurement at each determined occurrence;

recording each of said time measurements when the front and rear wheels pass into and out of each of said plurality of visible laser beams, respectively; and calculating a speed value and an acceleration value from said fixed distance and each of the time measurements recorded in said step of recording.

8. A method according to claim 7, further comprising the steps of:

obtaining exhaust emissions data from the motor vehicle; and

displaying the calculated speed value and the calculated acceleration value.

9. Apparatus for detecting acceleration of a motor vehicle passing along a roadway comprising:

means for producing first and second visible laser beams spaced apart by a predetermined distance on one side of the roadway and arranged at a height above the roadway so as each to be interrupted by a front wheel and a rear wheel of the motor vehicle;

detector means arranged at a side of the roadway opposite said one side for receiving said first and second visible laser beams and producing respective output signals indicating interruptions of said first and second visible laser beams by the front and rear wheels of the motor vehicle;

measuring means for receiving said output signals from said detector means for producing time measurements at each occurrence of said interruptions of said first and second visible laser beams and for producing time measurements at each resumption of each interrupted first and second visible laser beams; and

calculating means receiving said time measurements from said measuring means for calculating an acceleration of the motor vehicle based on said predetermined distance.

[11] Patent Number: 5,812,249

[45] Date of Patent: Sep. 22, 1998

*Attorney, Agent, or Firm*—Hunton & Williams

[57] ABSTRACT

Apparatus for obtaining the speed and acceleration of a motor vehicle in which the speed and acceleration are used in combination with exhaust emissions data obtained from the motor vehicle to analyze information about the pollutants being dispersed into the air by the motor vehicle. The apparatus includes a first radiation source producing a visible laser beam received by a first detector and a second radiation source producing a visible laser beam received by a second detector. The first and second radiation sources are arranged along the roadway with a known spacing and at a height so that the visible laser beams are interrupted by the front and rear wheels of the motor vehicle as it passes along the roadway. The detectors provide output pulses indicating whether the visible laser beams are interrupted and the time of the occurrence of each of the pulses is measured and recorded. An analyzer then calculates the speed and acceleration from the known spacing distance and the stored time measurements.

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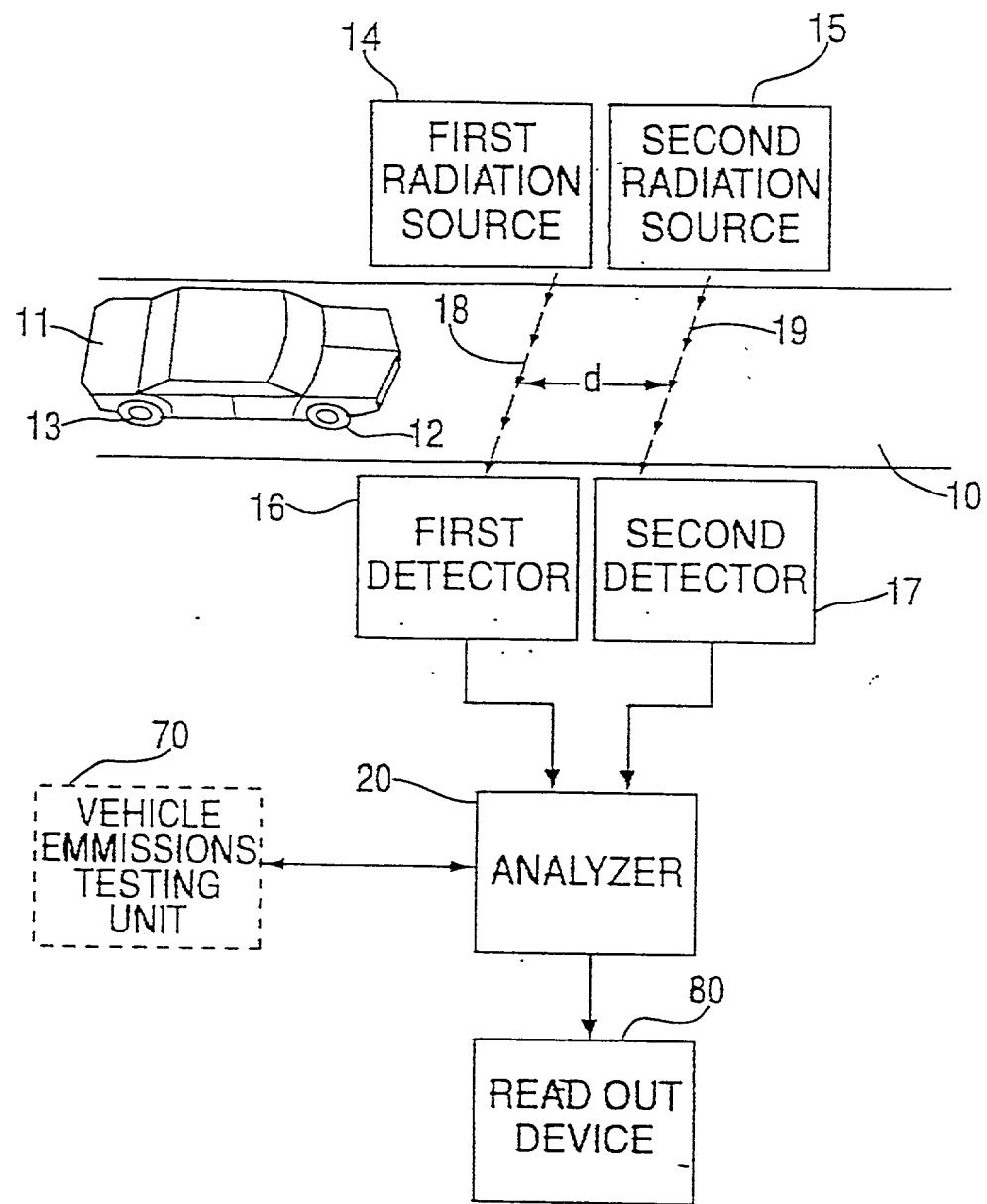


FIG. 1

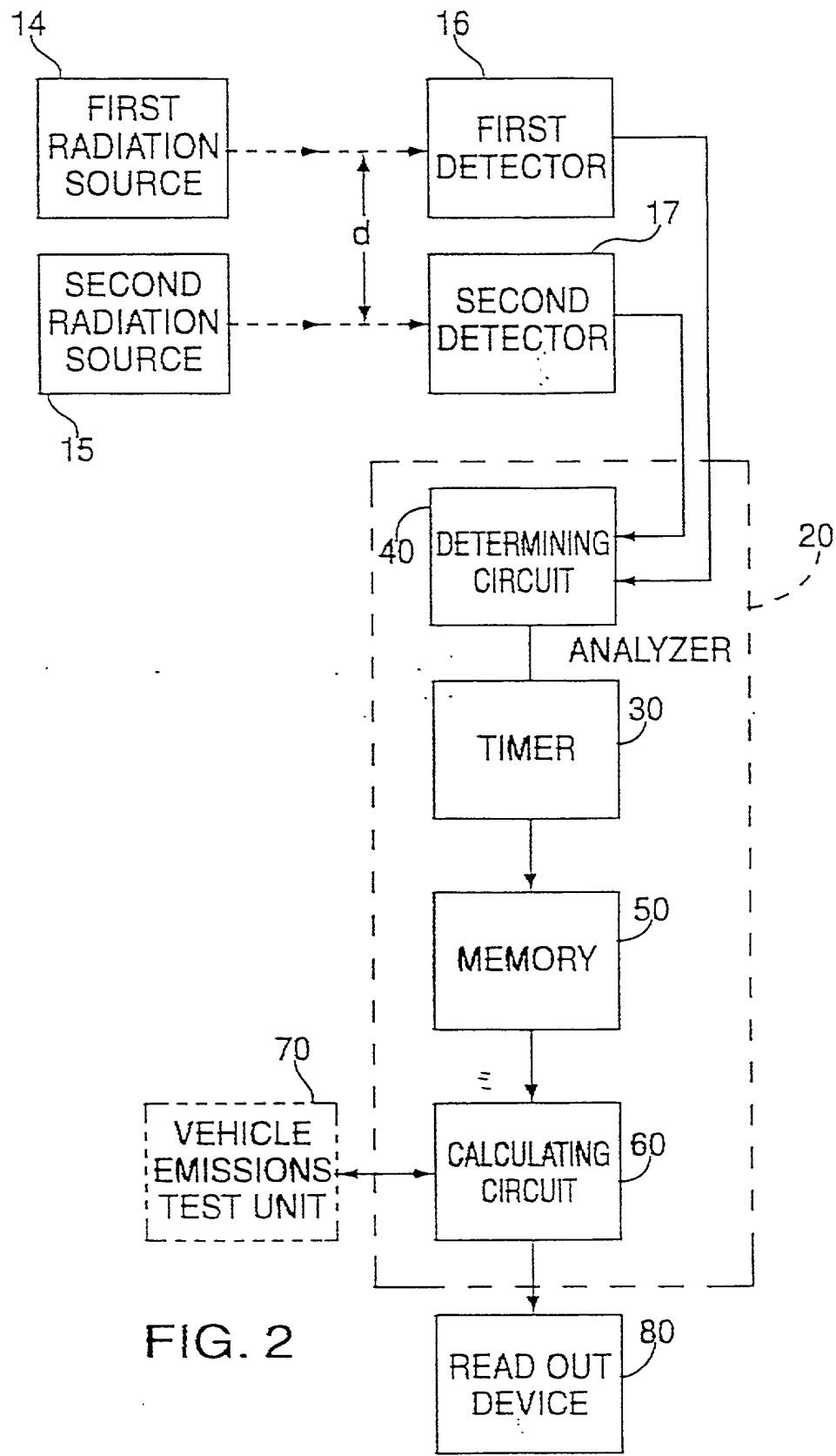


FIG. 2

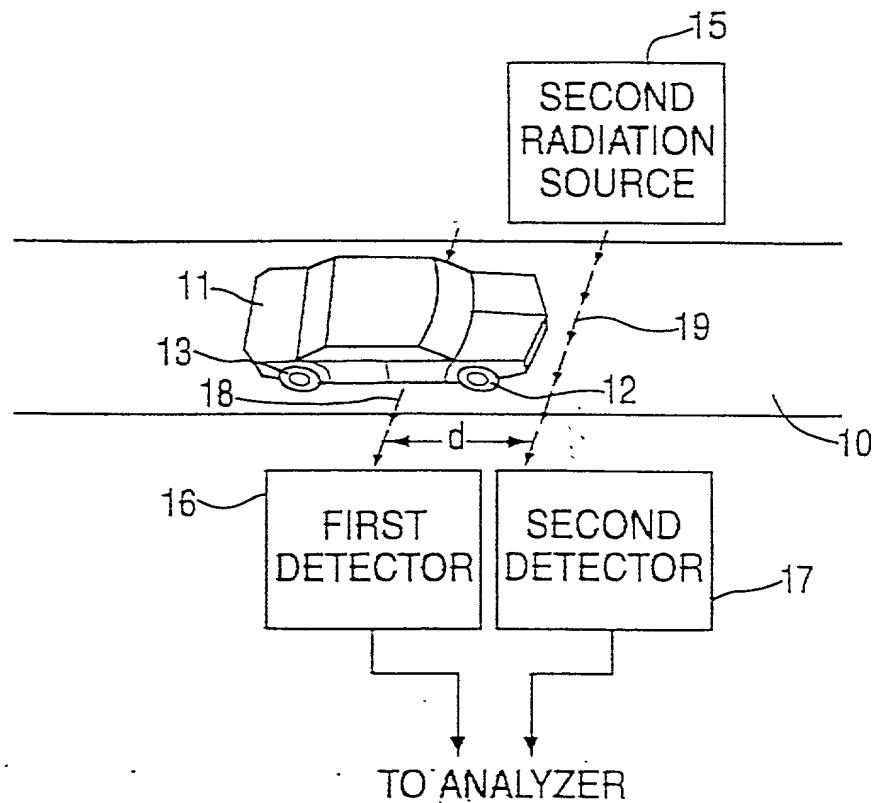


FIG. 3

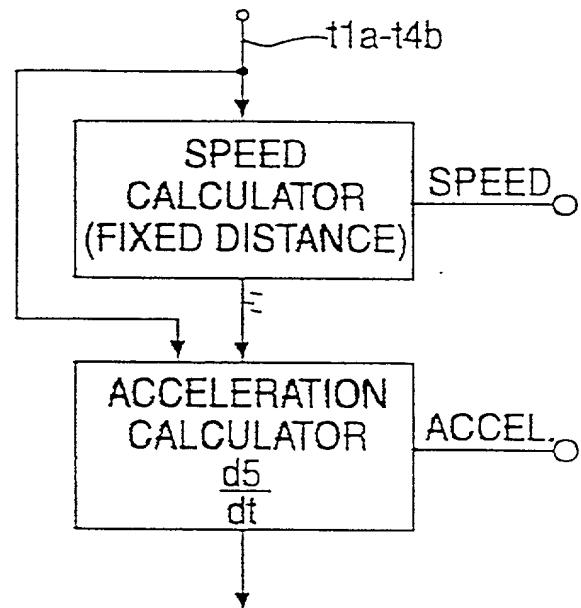


FIG. 4

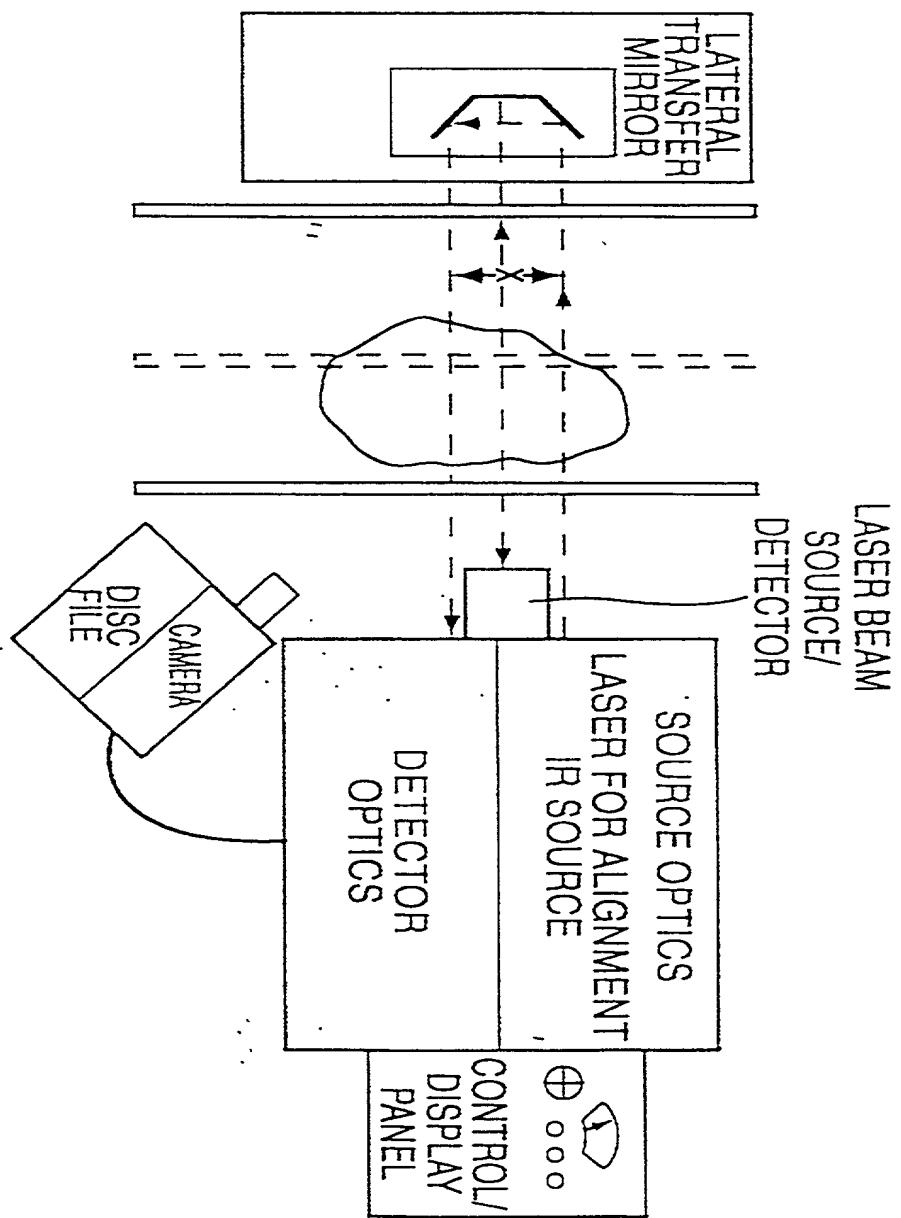


FIG. 5  
(PRIOR ART)

## REISSUE APPLICATION DECLARATION BY THE INVENTORS

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are stated below next to my name

I believe I am an original, first and joint inventor of the subject matter which is described and claimed in patent number 5,812,249, granted September 22, 1998, and for which a reissue patent is sought on the invention entitled, "SPEED AND ACCELERATION MONITORING DEVICE USING VISIBLE LASER BEAMS," the specification of which was filed on September 22, 2000, as reissue application number       /      , and was amended on September 22, 2000.

I have reviewed and understand the contents of the above identified specification, including the claims, as amended by the amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I verily believe the original patent to be wholly or partly inoperative or invalid by reason of the patentees claiming more or less than they had the right to claim in the patent.

At least one error upon which reissue is based is the unnecessary limitation of "visible" which was included in claims 1, 2, 5, 7 and 9.

Every error corrected in this reissue application, including all errors corrected in the amendment referred to above, arose without any deceptive intention on the part of the applicants.

We hereby appoint, both jointly and severally, as our attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith the following attorneys, their registration numbers being listed after their names:

Thomas J. Scott, Jr., Registration No. 27,836; Stanislaus Aksman, Registration No. 28,562; James G. Gatto, Registration No. 32,694; Christopher C. Campbell, Registration No. 37,291;; Henry C. Su, Registration No. 37,738; Brian M. Buroker, Registration No. 39,125; Charles F. Hollis, Registration No. 40,650; Jonathan D. Link, Registration No. 41,548; Kevin T. Duncan, Registration No. 41,495; George Georgellis, Registration No. 43,632; Stephen T. Schreiner, Registration No. 43,097; Christopher J. Cuneo, Registration No. 42,450; Raphael A. Valencia, Registration No. 43,216; Scott D. Balderston, Registration No. 35,436; Steven P. Klocinski, Registration No. 39,251; Yisun Song, Registration No. 44,487; Jennifer A. Albert, Registration No. 32,012; Kerry Owens, Registration No. 37,412; Milan M. Vinnola, Registration Number 45,979; Devin S. Morgan, Registration No. 45,562; Andrew J. Ririe, Registration No. 45,597; Carl Benson, Registration No. 38,378; Thomas E. Anderson, Registration No. 37,063; Thomas Blasey, Registration No. 33,475; Robin Clark, Registration No. 40,956; René Vazquez, Registration No. 38,647; Stuart I. Smith, Registration No. 42,159; Ozzie Farres, Registration No. 43,606 and David M. Huntley, Registration No. 40,309.

All correspondence and telephone communication should be addressed to James G. Gatto, Hunton & Williams, 1900 K Street N.W., Washington, D.C. 20006-1109, telephone number (202) 955-1500, which is also the address and telephone number of each of the above listed attorneys.

I hereby declare that all statements made herein of my own knowledge are true and that all statements on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine and imprisonment, or both, under 18 U.S.C. 1001, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which the declaration is directed.

Signature \_\_\_\_\_ Date \_\_\_\_\_

First Inventor: **James H. Johnson**

Residence: \_\_\_\_\_

Post Office Address: \_\_\_\_\_

Citizenship: U.S.A. \_\_\_\_\_

Signature \_\_\_\_\_ Date \_\_\_\_\_

Other Inventor: **John Di Domenico**

Residence: \_\_\_\_\_

Post Office Address: \_\_\_\_\_

Citizenship: U.S.A. \_\_\_\_\_

PATENT  
Attorney Docket No. 47382.000060

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Patent No.: 5,812,249 )  
Issue Date: September 22, 1998 )  
Application No.: 08/717,226 )  
Filing Date: September 26, 1996 )

**37 C.F.R § 3.73(b) STATEMENT AND POWER OF ATTORNEY**

Assistant Commissioner of Patents  
Washington, D.C. 20231

Sir:

I, the undersigned representative of Envirotest Systems Corp., the present owner of the patent identified above, as certified below in accordance with 37 C.F.R. § 3.73(b), hereby revoke all prior Powers of Attorney given for the patent and its associated application and appoint: Thomas J. Scott, Jr., Registration No. 27,836; Stanislaus Aksman, Registration No. 28,562; James G. Gatto, Registration No. 32,694; Christopher C. Campbell, Registration No. 37,291; Henry C. Su, Registration No. 37,738; Brian M. Buroker, Registration No. 39,125; Charles F. Hollis, Registration No. 40,650; Jonathan D. Link, Registration No. 41,548; Kevin J. Dunleavy, Registration No. 32,024; Kevin T. Duncan, Registration No. 41,495; George Georgellis, Registration No. 43,632; Christopher J. Cuneo, Registration No. 42,450; Raphael A. Valencia, Registration No. 43,216; Scott D. Balderston, Registration No. 35,436; Stephen T. Schreiner, Registration No. 43,097; Steven P. Klocinski, Registration No. 39,251; Yisun Song, Registration No. 44,487; Jennifer A. Albert, Registration No. 32,012; Kerry Owens, Registration No. 37,412; Devin S. Morgan, Registration No. P-45,562; and Milan Vinnola, Registration No. P-45,979 as their attorneys and agents with full power of substitution and revocation, to take any action with regard to this patent, and requests that all correspondence regarding this patent be sent to:

Kevin J. Dunleavy, Esq.  
HUNTON & WILLIAMS  
1900 K Street, N.W., Suite 1200  
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Telephone: (202) 955-1500  
Facsimile: (202) 778-2201

PATENT  
Attorney Docket No. 47382.000016

CERTIFICATE UNDER 37 C.F.R. § 3.73(B)

ENVIROTEST SYSTEMS CORP. certifies that it is assignee of the entire right, title and interest in the patent identified above by virtue of a chain of title from the inventor(s) of the patent identified above, to the current assignee as shown below:

1. From: James H. Johnson et al.  
To: Envirotest Systems Corp.  
The document was recorded in the Patent and Trademark Office  
at Reel 8324, Frame 0932

The undersigned (whose title is supplied below) is empowered to sign this certificate on behalf of the assignee.

I hereby declare that all statements made herein of my own knowledge are true, and that all statements made on information and belief are believed to be true; and further, that these statements are made with the knowledge that willful false statements, and the like so made, are punishable by fine or imprisonment, or both, under Section 1001, Title 18 of the United States Code.

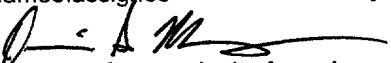
Date

2/29/00

  
Signature of Legal Representative of  
Envirotest Systems Corp.

Name: LAURENCE DAVID HURWITZ  
Title: VP & GENERAL COUNSEL

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

|   |                                |  |
|---|--------------------------------|--|
| <b>REISSUE APPLICATION BY THE ASSIGNEE,<br/>OFFERTOSURRENDERPATENT</b>  |                                | Docket Number (Optional)<br>47382.000060 |
| This is part of the application for a reissue patent based on the original patent identified below.   |                                |  |
| Name of Patentee(s):<br>James H. Johnson and John Di Domenico   |                                |  |
| Patent Number<br>5,812,249  | Date Patent Issued<br>09/22/98 |  |
| Title of Invention<br>Speed and Acceleration Monitoring Device Using Visable Laser Beams  |                                |  |
| <p><u>Envirotest Systems Corporation</u> is the assignee of the entire interest in the original patent.</p> <p>I offer to surrender the original patent.</p> <p><input checked="" type="checkbox"/> A certificate under 37 CFR 3.73(b) is attached.</p> <p>I am authorized to act on behalf of the assignee.</p>  |                                |  |
| <p>I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application, any patent issued thereon, or any patent to which this declaration is directed.</p> |                                |  |
| <p>Name of assignee Envirotest Systems Corporation</p> <p></p> <p>Signature of person signing for assignee<br/>Devin S. Morgan Reg. No. 45,562</p> <p>Date 09/22/00</p>  |                                |  |
| <p>Typed or printed name and title of person signing for assignee<br/>Devin S. Morgan Attorney of Record</p>  |                                |  |

Burden Hour Statement: This form is estimated to take 0.1 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.